Synopsis

Ph.D.in Food Service Management and Dietetics

Cultivation and Nutritional Profiling of Selected Varieties of Microgreens and their Acceptability in Incorporated Recipes

Submitted by

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Submitted to

Avinashilingam Institute for Home Science and Higher Education for Women

Coimbatore

January, 2023

Introduction

Microgreens, also known as 'Vegetable Confetti,' are a type of distinguishing crop that are described as young and delicate greens grown from the seeds of cereals, vegetables or herbs as well as plants from the wild. Since there has been a surge in the necessity and popularity of healthy eating, gourmet cuisine and indoor gardening are practiced in developed nations with cultivation of micro greens seeing significant increase. Even in the refrigerator, this new type of food has a short shelf life and is used in little amounts as garnishes, toppings or spices (Riggio *et al*., 2019). The Microgreens was reported to have more amount of vitamins and minerals compared to mature greens (Mir *et al*., 2017). Microgreens are abundant in vitamins, minerals and beneficial plant components and consuming them has been linked to a lower risk of numerous illnesses (Bazzano *et al*., 2002; Carter *et al*., 2010). Microgreens are also rich in essential elements that help us stay healthy. In view of the facts, the research was conducted to record the growth pattern of different varieties of microgreens, to develop various microgreen-based recipes and to impart awareness through live training sessions to self-help groups. By considering the facts the study was done with the following objectives:

- To study the type of medium and other growing conditions required for the cultivation of the selected microgreens.
- To study the growth of selected varieties of microgreens and to analyze the nutrient content, toxic elements and their shelf life.
- To develop recipes with grown varieties of microgreens and to analyze their sensory characteristics.
- To analyze the Knowledge, Attitude &Practice (KAP) of the selected subjects with respect to Microgreens.
- To impart awareness to selected subjects regarding the cultivation techniques and benefits of microgreens

Methodology

Study was carried out in three phases as:

Phase I **:** Cultivation and growth of selected varieties of microgreens.

Phase II **:** Analysis of microgreens and development of microgreen-based recipes.

Phase III **:** Analyzing the Knowledge, Attitude and Practice (KAP) and creating awareness among self-help groups.

Phase I: Cultivation and Growth of Selected Varieties of Microgreens

Pilot Study

The pilot study was conducted to analyze the best growing medium and other parameters suitable for the conduct of the study. Mustard microgreen was selected for the conduct of the pilot study. The different growing medium taken for the growth of microgreens include black soil mixed with sand, vermicompost mixed with sand and cocopeat mixed with sand (Minh& Thuong,2022). The various parameters selected for the growth of microgreens were watering methods (top and bottom watering) and lighting methods include direct lighting(sunlight), partial lighting and Light-Emitting Diode (LED*)* lighting. Based on the pilot study results, the best growing medium and the other parameters were finalized and further study was carried out using the same.

The study was approved by the Institutional Human Ethical Committee (IHEC/19-20/FSMD-29) of Avinashilingam Institute of Home Science and Higher Education for women.

Selection of Samples, Minor Equipments and Other Accessories:

The selected samples for the study were six types of microgreens seeds (Mustard Microgreen (Brassica juncea)from Brassica family, Chia Microgreen (*Salvia hispanica*) from Mint family ,Fenugreek Microgreen (*Trigonella foenum-graecum*) from the Fabaceae family ,Beetroot Microgreen (*Beta vulgaris*) from the Amaranthaceae family ,Sesame Microgreen (*Sesamum indicum*) from Pedaliaceae family and Radish Microgreen (*Raphanus sativus*) from Brassicaceae family).

These microgreens were selected because they were not consumed by the general public. Further, these can be easily grown in a small space and within a short span of time. It contains significantly higher amount of nutrients when compared to normal greens. On top of the above, as the microgreens are grown in a controlled condition with selected medium and light etc.., it avoids the presence of heavy metals like lead, arsenic etc.. In addition, these microgreens have a peculiar flavor and texture which is completely different from the normal greens making it more acceptable for consumption. Also, these microgreens are very tender and delicate making it is a very suitable ingredient to be added in any type of recipes especially salads.

The minor equipments and other accessories which were selected for the conduct of the study include potting container, cocopeat mixed with sand in the ratio, microgreen seeds, water sprayer, aluminum foil paper and scissors.

Cultivation Process of Microgreens Seeds

The process of cultivation of the microgreens was done in different growing mediums, watering methods and lighting conditions. The best method was selected according to the positive growth pattern of microgreens in each growing condition established.

The cultivation process in the growing of microgreens is as follows:

The first step is filling the containers with different mediums like black soil mixed with sand, vermicompost mixed with sand and cocopeat mixed with sand. Then the Microgreen seeds are to be spread on the medium surfaces evenly. After the spreading of seeds, an adequate amount of water is sprayed. The different watering method administered were Top and Bottom Watering method. The lighting methods administered were direct lighting (sunlight), partial lighting and Light-Emitting Diode (LED*)* lighting. The entire tray is then covered with aluminum foil for two days. Proper observation is needed in the midst to see the moisture level. After two days, the seed trays are uncovered. After a week, the container will be full of healthy Microgreens. Once the plants are 2-3 inches taller, they are ready to be harvested. The harvested microgreens are washed and are used to enhance the meal.

Selection of Growing Medium

The growing medium which were selected for the production of microgreens were black soil mixed with sand, vermicompost mixed with sand and cocopeat mixed with sand. The pilot study revealed that the growing medium which was suitable for the positive growth of microgreens was found to be cocopeat mixed with sand. Hence the selected six varieties of microgreens were further grown in cocopeat mixed with sand.

Exposure to Light

The microgreens were analyzed by subjecting them to various types and intensities of light. The microgreens were studied by subjecting them to direct lighting (sunlight), partial lighting (partial sunlight) and artificial lighting using Light-Emitting Diode (LED*)* lighting. The direct lighting was administered by exposing microgreens under direct sunlight, partial lighting was done by keeping microgreens inside room were sunlight is reached to microgreens partially & LED lighting was administered to the microgreens which were grown in a room where there was only LED bulb as the only source of light. The lighting method suitable for the growth of microgreens was partial lighting and the selected varieties of microgreens were further grown in partial lighting.

Watering Methods

Two types of watering methods were used to find out the better among them for the growth of microgreens. The two methods were top watering and bottom watering methods. In top watering method, the microgreens were watered using the water sprayer from the top and for the bottom watering the watering of microgreens were done by using the holed mudpots, where there was a base with water provided for the microgreens to absorb water. The microgreens grew best when they were watered from the top. Hence further conduct of the study was carried out with top watering method.

Analyzing the Growth of Cultivated Microgreens

The selected varieties of microgreens were grown in an eco-friendly way. They are grown in mud pots in the medium of cocopeat with sand. Water sprayer was used for watering the greens from the top. They were grown in a room with partial exposure to sunlight. The harvesting of the microgreens was done when they attain their maturity using sterilized scissors. The length of the stem and leaf size of the microgreens was analyzed using the vernier caliper.

Analysis of the Growing Medium used for the Cultivation of Microgreens

The analysis of the selected growing medium was done and results were recorded. The Cocopeat mixed with sand was analyzed for its nutrient content and microbial count. The suitable medium for the growth of plants was found to be cocopeat mixed with sand as it has healthy nutrients and useful microorganisms compared to the other two mediums. (Ganeshamurthy, A. N., *et al*.,2015)

Phase II: Analysis of Microgreens and Product Development

Analysis of Vitamins and Micronutrients in Selected Microgreens

The nutrient content of the fully matured microgreens was analyzed for micronutrients. The vitamins including Vitamin A, Vitamin D, Vitamin E, Vitamin K, Vitamin C, Thiamine, Riboflavin, Niacin, Pantothenic Acid and Folic Acid and minerals like Calcium, Phosphorous, Iron, Selenium, Potassium, Sodium, Magnesium, Fluoride, Manganese, Zinc and Copper were analyzed using the AOAC method for the selected varieties of harvested microgreens.

Analysis and Comparison of Vitamins and Mineral Content of Microgreens with the Regular greens/ Matured Counterparts.

The vitamin and mineral content of microgreens were analyzed (AOAC method) and compared with the mature counterparts.

Analysis of Phytochemical Contents in Selected Microgreens

The quantitative estimation of phytochemicals including flavonoids, total antioxidant activity, chlorophylls and β-carotenoids content in the selected microgreens were determined by aluminum chloride colorimetric technique and phosphomolybdenum method.

Analysis of Toxic Elements in Microgreens

Some greens cultivated in a certain type of soil were reported to have various heavy metals (Lenzi, A., *et al*,.2019). Hence the microgreens which were grown in cocopeat mixed with sand were analyzed for the presence of heavy metals using AOAC.15.01 method, which was used for the determination of the heavy metals including lead, cadmium, mercury and arsenic.

Analysis of Shelf life of Microgreens

Shelf-life analysis of cultivated microgreens was conducted in different storage conditions. The shelf life of the microgreens was done in various types of containers as well. The atmospheric conditions chosen for conducting analysis were normal room temperature and refrigerator temperature. They were stored in food grade plastic containers, glass containers, steel containers, mud pots, paper bags and polyethylene bags. The shelf life of the selected varieties of microgreens was observed for 3 days.

Formulation of Recipes with Cultivated Microgreens

The microgreens which were harvested was processed and used for the preparation of value-added recipes. The recipes which were prepared with the grown varieties of microgreens include salads and juices, starters, desserts, main dish, side dish, ready to cook& ready-to-eat foods. Microgreen based salads and juices was micronutrient rich as there is less loss of nutrients from the microgreens. The other recipes apart from salads and juices were planned to avoid monotony. This enables home makers to incorporate them into several other dishes like starters, main dish, deserts etc. so that there is variety and enhanced consumption across all age groups. And further for those who lack time to prepare elaborate recipes, the ready to eat and ready to cook recipes were developed.

Salads:

The salads prepared with microgreens include sprouts green salad, green nutri salad, protein green salad, green fruit salad, mixed green salad, fish green salad, roasted vegetable salad with green mix, chicken green salad, classic green salad and grilled green vegetable salad.

Juices:

The juices prepared with cultivated microgreens was green lime juice, green cucumber juice, green mojito, green kiwi juice, amla green juice, green mango juice, green passion fruit juice, green apple juice, green freshener juice and green mint juice.

Starters

The starters prepared using cultivated microgreens were vibrant spring soup, green goddess dressing, green bajji, green balls,green rolls, green kabab, green dal vada,green semolina veggie rolls, healthy green momos and green fritters.

Desserts:

The prepared desserts were khulfi, green fruit yoghurt, green mix stuffed gulab jamuns, green khoa, green honey cake, green pudding, green praline, nutrient rich macroons, green custard and green biscuit cake.

Main dish:

The main dishes which were prepared using selected microgreens include chia green elaada,mustard green breakfast wraps, radish green chappathi, fenugreek green biriyani, green sandwich, radish green idiyappam, green kozhukatta, beet green orotti, sesame green masala rice and mustard green puttu.

Side dish:

The side dishes prepared were beet green chutney, green pachadi, green buttermilk, sesame green thoran, fenugreek green eruchery, green dal curry, radish green kulambu, mustard greens gram curry, go green bowls, green mezhukuperatty.

Ready to eat

The prepared ready to eat foods with cultivated microgreens were green bhel puri, green pea dip,green fries, nutria mix , green mixture, green pizza base, green cookies, green jam, green mayonnaise and green pickle.

Ready to cook:

The ready to cook dishes prepared were mustard soup powder,microgreen leaves steam cake powder, green custard powder, healthy noodles, instant green payasam mix, ready to cook green uppma mix, instant sambar mix, instant rasam powder, green pancake mix and ready to cook kebab.

Determination of Nutritive Value and Sensory Evaluation of the Microgreen based Recipes

Determination of Nutritive Value of Recipes

The nutrients for each microgreen-based recipes like salads and juices, starters, desserts, main dish, side dish, ready to cook & ready-to-eat foods were determined. The micronutrient content in microgreens were obtained from the lab analyzed value and other nutrients from the Indian Food Composition Tables,2017.

Sensory evaluation of the recipes

Sensory evaluation was performed to assess the quality of food in terms of its organoleptic properties. The characteristics of food materials includes, sense of sight, smell, taste, touch, and sound which are measured, analyzed and interpreted using a scientific tool known as sensory evaluation (Lawless *et al*.,2010). Considering the importance of sensory evaluation, recipes were examined by selected semi-trained panel numbers. The 9-point hedonic scale was used for the sensory evaluation of the study. The test was conducted to evaluate characteristics such as color, taste, appearance, flavor, and overall acceptance. Recipes were presented to each of the panelist and the scoring was done individually.

Design of Experiments

Based on the design of experiments, further analysis was done. Design of experiments (DOE) is outlined as a branch of applied statistics that deals with designing, conducting, analyzing, and deciphering tests to gauge the factors that control the worth of a parameter or cluster of parameters. After the nutritive value determination of recipes, they were analyzed based on the design of experiments. The nutrient significance of microgreen-based recipes was found using design of experiments.

Phase III: Knowledge, Attitude &Practices (KAP) on Microgreens and Creating Awareness on Cultivation and Importance of Microgreens among Self Help Groups (Kudumbashree)

Analysing the Knowledge Attitude Practices (KAP) on Microgreens among Self Help Groups (Kudumbashree)

Selection of Subjects:

The selected subjects were from the Kudumbashree self-help groups from Kottayam district, Kerala. Totally 81 women subjects in the age group of 35-65 were selected by purposive random sampling method . Judgmental or subjective sampling method is the other term for purposive sampling method It is a form of non-probability sampling. In purposive

sampling method, the participants among the population are selected based on the judgment of the researcher itself (Kothari and Garg, 2019).

Assessment of Pre-Knowledge, Attitude& Practices (KAP) on Microgreens

The Knowledge Attitude and Practices (KAP) survey is a quantitative method (predefined questions formatted in standardized questionnaires) that provides access to quantitative and qualitative information. The subjects were oriented about the purpose and conduct of the study. Before the assessment the samples were clearly explained about the objectives of the questions and how to approach the questions. This orientation helped in smooth conduct for collection of data. For the live training session ,45 subsamples were taken from the total samples. The selection of subsamples for live training session was based on the willingness and interest of the samples to grow microgreens in their kitchen garden.

Imparting Awareness to Selected Subjects on Cultivation and Importance of Microgreens

The live training session was given to the self - help group on cultivation methods, nutritional benefits, storage techniques, and how they can be incorporated into various recipes were explained. The sessions were conducted with the help of the microgreen seeds, mudpots, scissors, water sprayer and growing medium.

Assessment of Post -Awareness Knowledge among Self-Help Groups (Kudumbashree) on the Cultivation of Microgreens

After the live training session, a set of questions were asked to the women of Kudumbashree units to assess their knowledge and feedback on the session. The scoring was done in same method as it was done for the pre awareness session. The pre awareness and post awareness knowledge scores were analyzed and recorded.

Salient Findings of the Study:

Phase I: Cultivation and Growth of Microgreens, Growing Medium and Environment Selected for the Study and Analysis of Growth of Selected Microgreens

- The selected microgreen seeds for the cultivation were Mustard and Radish greens from Brassicacea family, Beet greens from Amaranthaceae family, Chia greens from Lamiaceae family, Sesame greens from Pedaliaceae family and Fenugreek greens from Fabaceae family.
- A pilot study was conducted to analyze the best growing medium suitable for the growth of microgreens and also to analyze the better environmental conditions, especially the lighting method and the watering method suitable for the growth of microgreens.

- Mustard microgreens were selected for the conduct of the pilot study with different mediums. The growing patterns of microgreens in vermicomposting mixed with sand, black soil mixed with sand and cocopeat mixed with sand were studied for seven days (till it attain maturity). The effects were analyzed and found that the microgreens are not growing well in the medium of vermicompost mixed with sand and black soil mixed with sand, but was growing well in cocopeat mixed with sand. Cocopeat mixed with sand was found to be the best medium for the growth of the microgreens.

- For the study on the cultivation of microgreens, various growing conditions were analyzed and studied. The mustard microgreens which were grown in cocopeat with indirect lighting (LED lighting) and top watering method was found to have the best environmental condition suitable for the growth of the microgreens was this method as it resulted in best yield and stature at the time of cultivation.

- The best growth pattern was observed in fenugreek microgreens and radish microgreens followed by mustard microgreens and chia microgreens. Once the microgreens are 2-3 inches taller, they are ready to be harvested. The harvested microgreens are washed and are used to enhance the meal.

- Association between stem length and microgreens (Mustard Microgreen, Chia Microgreen, Beetgreen Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) from day 1 to day 7 were analyzed through One-Way ANOVA. It was clear that there was a statistical significant association between the growth of stem length and the selected microgreens.

- Association between leaf size and microgreens (Mustard Microgreen, Chia Microgreen, Beetgreen Microgreen, Sesame Microgreen, Fenugreek Microgreen and Radish Microgreen) from day 1 to day 7 were analyzed through One-Way ANOVA. It was clear that there was a statistical significant association between the leaf size and the selected microgreens.

- The laboratory analysis was done to assess the nutrient content of the growing medium, cocopeat. pH value of the cocopeat was found to be 7.2 and the peat was basic in nature. The total nitrogen content was 4.09%. The average phosphorus content was 12.6-13.01 mg/kg and the average potassium was 4.1-4.31 mg/kg and the organic carbon present in cocopeat was 47.4%.

Phase II: Analysis of Microgreens and Product Development

- The vitamin content of the cultivated microgreens were analyzed and it was observed that vitamin A,E,C and pantothenic acid was highest in mustard microgreens and vitamin K, thiamin, riboflavin, niacin and folic acid was highest in beet greens microgreens. Radish microgreens has the least number of vitamins compared to the other microgreens. Mineral content of selected microgreens were also analyzed and observed that chia microgreens contain higher amount of potassium. Sesame microgreens had higher amount of iron, selenium, manganese and zinc. Radish microgreens were rich in phosphorous and beet green microgreens were high in calcium, sodium, and magnesium.

- Antioxidant activity was analyzed and it was found that the fenugreek microgreen had high antioxidant activity among all other microgreens. The sesame microgreens had highest amount of chlorophylls, β – carotenes and flavonoids .

- The toxic elements were analyzed in the cultivated microgreens. The toxic elements like lead, cadmium,mercury and arsenic was analyzed and found that no elements were in detectable level

- The microgreen-based recipes prepared were categorized into different categories including salads, juices, starters, side dish, main dish, desserts, ready to eat and ready to cook foods. Total 80 recipes were prepared, 10 recipes from each category. The sensory evaluation and nutritive value determination was done. The best scored recipes were microgreen based desserts, followed by microgreen based main dishes and side dishes.

Phase III: Analyzing the Knowledge, Attitude and Practices (KAP) on Microgreens and Creating Awareness among Selected Subjects

- The educational qualification of the subjects was assessed and it revealed that majority of them (25%) were degree holders. Considering the occupational status, majority of the subjects were teachers. Most of the subjects were married and were from nuclear family and most of them were from upper socio- economic status.
- The selected subject's knowledge in microgreens was assessed and it was found that majority (95%) of them doesn't know about microgreen seeds and very few of them (5%) know about microgreen seeds.

- Majority of the samples consumed green leafy vegetables below 400 gm per dayand only a few had consumed more than 400 gm of green leaves in their daily diet. Majority (89%) of the homemakers spend less than Rs.20 per day for the purchase of green leafy vegetables, while rest of the subjects (11%) spend Rs.20-100 per day for purchasing green leafy vegetables.
- Live training session was organized for the selected self-help groups that is Kudumbashree units. An interview schedule was used to analyze the knowledge level of the subjects regarding microgreens and it was found that majority had scored less than fifty percent before the training session. The same interview schedule was used to analyze the subjects knowledge after the awareness session and it was found that majority of them have secured more than fifty percent score.
- The pre and post knowledge assessment was done among selected subjects and it was statistically significant proving that there was considerable increase in their knowledge level regarding the microgreens after the live training session.

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